CLAIMS

What is claimed is:

1. A defect detection system for detecting a defect in a structure, said system comprising:

a sound source for applying a sound input signal to the structure, said sound source being coupled to the structure in a manner so that the sound signal induces acoustic chaos in the structure that causes the structure to vibrate in a chaotic manner and heat the defect; and

a thermal imaging camera for generating thermal images of the structure to identify the heated defect.

2. The system according to claim 1 wherein a force is applied to the sound source to couple the sound source to the structure in a manner that generates the acoustic chaos in the structure.

3. The system according to claim 1 further comprising a coupler in contact with the sound source and the structure, said sound signal being coupled to the structure through the coupler, said coupler being made of a predetermined material and having a predetermined thickness that act to induce the acoustic chaos.

4. The system according to claim 3 wherein the coupler is a non-linear coupler.

5. The system according to claim 3 wherein the coupler is selected from the group consisting of copper, automotive gasket material, leather, duct tape, Teflon, paper products and cork.

6. The system according to claim 1 wherein the sound source includes a chaos signal generator and a transducer, said chaos signal generator generating a chaos signal that is applied to the transducer, said transducer causing the structure to vibrate in a chaotic manner.

7. The system according to claim 1 wherein the sound source includes an ultrasonic transducer, said ultrasonic transducer including a transducer horn that is coupled to the structure, and wherein the sound input signal generated by the ultrasonic transducer causes the transducer horn to impact against the structure.

8. The system according to claim 1 wherein the sound source includes an electromagnetic acoustic transducer.

9. The system according to claim 1 further comprising a device for determining vibrations of the structure in response to the sound input signal.

10. The system according to claim 9 wherein the device is a doppler laser vibrometer.

11. The system according to claim 9 wherein the device is a microphone.

12. The system according to claim 1 wherein the acoustic chaos is defined by a range of frequencies providing a vibrational waveform whose spectral content is related to the frequency of the sound input signal by ratios of rational numbers.

13. A system for creating acoustic chaos in a structure, said system comprising a sound source coupled to the structure under a predetermined force, said sound source applying a pulsed sound signal to the structure, wherein the amount of force, the duration of the pulsed sound signal and the frequency of the sound signal act to induce acoustic chaos in the structure and cause the structure to vibrate in a chaotic manner.

14. A defect detection system for detecting a defect in a structure, said system comprising:

an electronic chaos signal generator for generating a chaos signal;

a broadband transducer responsive to the chaos signal from the chaos signal generator; and

a coupler coupling the transducer to the structure, wherein the transducer converts the chaos signal to a sound signal that is applied to the structure through the coupler, wherein the sound signal induces acoustic chaos in the structure that acts to heat the defect.

15. A defect detection system for detecting defects in a structure, said system comprising:

a sound source for applying a sound input signal to the structure, said input signal including a plurality of frequency signals having different frequencies, said input signal heating the defects in the structure; and

a thermal imaging camera for generating thermal images of the structure to identify the defects.

16. The system according to claim 15 wherein the input signal is a combination of two or more frequency signals centered at different frequencies.

17. The system according to claim 15 wherein the input signal has a Gaussian frequency band.

18. The system according to claim 15 wherein the input signal is a chirp-signal whose frequency changes in time.

19. The system according to claim 15 wherein the input signal is a signature signal having a set of pseudo-random pulses.

20. The system according to claim 15 wherein the input signal has an increasing, decreasing or constant amplitude in various sequential combination, including optionally steps in amplitude.

21. The system according to claim 15 wherein the input signal is based on a rectangular frequency band.

22. The system according to claim 15 wherein the input signal is a favored envelope frequency including one pulse having a small pulse width and another pulse having a larger pulse width for detection of defects in different depths.

23. The system according to claim 15 wherein the sound source is selected from the group consisting of EMATs, ultrasonic vibrators, piezoelectric vibrators, electro-magnetic vibrators and magneto-strictive vibrators.

24. The system according to claim 15 further comprising a signal shaper, said signal shaper generating the input signal to have a predetermined duration, amplitude and frequency.

25. The system according to claim 15 wherein the sound source is a broad-band transducer capable of providing a broad-band frequency signal.

26. The system according to claim 15 wherein the sound source includes a plurality of transducers each being tuned to a different narrow band center frequency.

27. The system according to claim 15 further comprising a vibration sensor coupled to the structure, said vibration sensor sensing vibrations in the structure.

28. The system according to claim 27 wherein the vibration sensor is selected from the group consisting of an eddy current based vibration sensor, an accelerometer, an optical vibration sensor, a microphone, an ultrasonic transducer and an ultrasonic vibration sensor.

29. The system according to claim 27 wherein the vibration sensor measures a phase shift between current and voltage of the sensed vibrations to determine the natural frequencies of the structure.

30. The system according to claim 27 wherein the vibration sensor measures an amplitude characteristic of current or voltage of the sensed vibrations to determine the natural frequencies of the structure.

31. The system according to claim 15 wherein the input signal is a tuned excitation signal that provides an open-loop or a closed loop control.

32. A defect detection system for detecting defects in a structure, said system comprising:

a sound source for applying a sound input signal to the structure, said input signal having one or more frequencies or a single frequency signal with an amplitude modulation selected to be at or near an eigen-mode of the structure or selected to avoid the eigen-mode of the structure, said input signal heating the defects in the structure; and

a thermal imaging camera for generating thermal images of the structure to identify the defects.

33. The system according to claim 32 wherein the input signal is selected from the group of input signals consisting of an input signal having a combination of two or more frequency signals centered at different frequencies, an input signal that has a Gaussian frequency band, an input signal that is a chirp-signal, an input signal that is a signature signal having a set of random pulses, an input signal that has a rectangular frequency band, an input signal that has an increasing amplitude with a step, and an input signal that includes one pulse having a short pulse duration and another pulse having a wide pulse duration for detection of defects in different depths.

34. A defect detection system for detecting defects in a structure, said system comprising:

a sound source for applying a sound input signal to the structure, said input signal being a single frequency signal with an amplitude modulation, said input signal heating the defects in the structure; and

a thermal imaging camera for generating thermal images of the structure to identify the defects.